Does liquidity information matter?:
A view from fixed income dealers

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DOES LIQUIDITY INFORMATION MATTER?:
A VIEW FROM FIXED INCOME DEALERS

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ABSTRACT
Both the inventory theory and the asymmetric information theory assume that dealers possess no information advantage compared to other market participants. However, dealers can observe market liquidity from more aspects than any other participants do, and therefore have better information on market liquidity. Does this liquidity information advantage lead to profit? Using a detailed 3-month transaction data from London Stock Exchange, I examined dealer's information advantage by analyzing dealers' trading revenue and the components. The results strongly support that liquidity information does matter to dealers.
1. INTRODUCTION
The study of market liquidity has gained academic attention due to recent crises, which depress asset returns and affect the efficient operation of the financial market. With the availability of transaction data, studies on liquidity have extended from the equity market to the foreign exchange market, the government market and most recently, the corporate bond market.1

Liquidity researches usually focus on two areas: First, the relation between asset return and its liquidity; and second, identifying and comparing different liquidity proxies. Most research from the first area has found that liquidity is priced in the asset price, and that a liquidity premium does exist in the equity market, foreign exchange market, and fixed income securities market. Researches in the second area are expanding quickly.

Liquidity refers to the easiness to trade an asset at a fair price and in a timely manner. It arises from the demand and supply of the asset in the market. In a dealership market, the market makers’ are the liquidity providers. They directly observe the security's liquidity status. But in market microstructure theories, where the dealer's pricing rule and trading behavior are modeled, they are not modeled as having advantages on liquidity information.2

If liquidity does affect asset return, then information on liquidity is valuable. If dealers have an advantage in accessing liquidity information, can they consistently make profits from this advantage? It is the aim of this paper to bridge this gap between the literature on liquidity and the literature on market microstructure. We analyze the significance of liquidity information by examining dealers’ trading revenue in the London's fixed-income securities market.

Different liquidity proxies have been used to measure different aspects of bond liquidity, such as trading activity, number of dealers and the bond-specific characteristics. Some of these proxies, such as bond specific characteristics, can be directly observed by the public. But the public cannot directly observe proxies that are related to trading activities. This is because the fixed income market is mainly an over-the-counter market. Trading information is not directly and immediately disseminated across the market. Dealers, however, as liquidity providers, observe most of the trading activities and therefore have a better understanding of market liquidity than any other market participant does. Private fundamental information in the risky fixed-income securities market is less prominent than that in the equity market, because bonds' future cash flows are well scheduled, and have less risk than equity shares from the same issuer. Therefore, liquidity information may play a more significant role in the market.

We first examine whether market making in this market is profitable. Then we examine whether dealers with a higher level of liquidity information outperform dealers with a lower level of information. Next we estimate the bid-ask spread of securities from transaction data, and finally decompose the dealer's total trading revenue into spread revenue and position revenue. The position revenue summarizes the dealer's ability to earn a profit from his information.

We find that in general, dealers earn positive trading revenue, but not position revenue. We find for dealers as a whole, liquidity information positively contribute to position revenue but not statistically significant. While considering dealers possessing different level of information, we find that those dealers who have higher level of liquidity information earn much more than other dealers do. Our results thus support the hypothesis that, not only liquidity status affects asset value, but that liquidity information itself also generates profit.

The rest of the paper is organized as follows. Section 2 presents a literature review on a dealer's trading revenue from theoretical and empirical studies.

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2 We use market maker and dealer interchangeably.

3 Inventory theory model assumes that there is no information relates to asset payoffs prevailing in the market. The dealer's trading rule is governed by his perception of incoming order flow in order to keep his inventory in equilibrium. Asymmetric information theory realizes that informed traders have private fundamental information on the asset value, and dealer trade to balance their loss to informed traders. In this type of theory the information prevailing is the fundamental information that relates to the payoff of the asset, and it is the informed public trader, but not the dealer that has the information. Although later theories suggest dealer may act strategically to gain information from informed order flow, none of the theories suggests that dealers have information advantage and could be benefit from their information advantage.
aspects. Section 3 describes the data we use. Section 4 presents the methodology used, and the estimation procedure. Section 5 discusses the empirical results. In Section 6 we summarize the study.

2. LITERATURE REVIEW

2.1 Implications of market microstructure theory

The traditional market microstructure theories model market maker trading behavior from two main considerations: the inventory control consideration and the asymmetric information consideration.

In inventory models such as Garman (1976), Amihud and Mendelson (1980), and Ho and Stoll (1983), the underlying assumption is that no traders (including market makers and public traders) have superior information on a security’s fundamental value. Even in a multiple dealership market, dealers have the same level of knowledge on the fundamental value of a security. In such a setting, the dealer's main problem is to set the price to balance the incoming flow of orders and keep his inventory in a certain preferred range. This happens because the direction of the next period’s incoming order flow is never certain and an order flow imbalance is inevitable. The preferred inventory works purely as a buffer to balance the incoming orders. As a result, dealers do not expect to earn profit from their inventory. Furthermore, because dealers do not trade on their knowledge of fundamental information, the effect of their trading behavior on the price of a security is only temporary as the price converges to true value in the long run, when order flows are balanced. So whether the inventory position will eventually earn them profit is ambiguous. In the inventory model, dealers will earn bid-ask spread, but when they execute trades that will lead the inventory to deviate from the desired level, this spread revenue will be eroded by the deterioration of inventory.

If the prediction of a dealer’s profit from the inventory model is only inferential, asymmetric information theories make strong predictions about a dealer’s trading profit.

In asymmetric information models of market making such as Copeland and Galai (1983), Glosten and Milgrom (1985), Kyle (1985), and Admati and Pfleiderer (1988), the common fundamental assumption is that asymmetric information prevails in the market. The dealer faces two types of traders: the informed trader and the uninformed trader. The informed trader has a certain level of private information of the security value, so he/she can buy low and sell high. The uninformed trader trades because of liquidity reasons that are unrelated to the security’s fundamental value. A dealer doesn’t have an information advantage over the informed trader but he does know that if he trades with an informed trader he will always lose. The dealer’s problem in price-setting is to offset losses from trading with informed traders by trading gains from uninformed traders.

Copeland and Galai (1983) modeled a risk-neutral dealer's one-period pricing rule. Dealer's gain is a weighted-average of expected loss from informed trade and expected gain from uninformed trade. The weight is the probability of informed trades and the probability of uninformed trades. The bid-ask spread arises as a dealer maximizes this gain. If competition is introduced in this monopolistic framework, a dealer’s gain in equilibrium will reach zero, and as a result, spread revenue will just compensate the losses to the informed trader. This is the explicit assumption of Glosten-Milgrom’s (1985) model. In this model, risk-neutral dealers set prices under the condition of zero expected trade profit. Because each market maker has the same level of knowledge of a security’s value and trade information, they will have the same pricing rule. This zero-profit equilibrium condition is also found in other models, which model the strategic trading behavior of traders, as researched in Kyle (1985) and Admati and Pfleiderer (1988).

To sum up, the asymmetric information model has two implications on dealer profit: First, in a competitive dealership market, spread revenue will be perfectly offset by position loss, so dealers should earn zero total profit in equilibrium. Second, dealers are homogeneously non-informed traders. They have the same level of fundamental information and market information, so cross-sectionally, they will earn zero total profit.

In practice, at least three facts contradict the previous theory: first, as we discussed in the introduction, dealers do have market information that is not available to informed traders. Second, the information dealers have is not homogeneous. Dealers may either have more skill, which enables them to interpret trade information better than others, or they may simply observe more trade than others do, and consequently have a better understanding of market liquidity. All the liquidity information helps them make better predictions.
about asset prices which impact their trading decisions. Third, dealers may have other ways to infer the information contained in a security rather than trade with informed traders. It is common for dealers usually to hold more than one security. If the securities are correlated, information can be implied from trading in other securities. This information, either fundamental or non-fundamental, helps dealers make better trading decisions.

2.2. Empirical researches on dealers’ trading revenue

In most previous empirical studies on market microstructure, investigation into dealers’ trading revenue is limited to spread revenue only. Results on position revenue are only inferential. It was only recently, when detailed transaction data became available, that a detailed estimation of a dealer’s trading revenue became possible. But even with detailed transaction data, an estimation of position revenue is still subjective to some extent, because position revenue depends on a dealer’s inventory and the liquidity price of the inventory, while the benchmark for the liquidity price is difficult to decide.

Manaster and Mann (1998) analyze the trading revenue of futures traders on the Chicago Mercantile Exchange during the first six-months of 1992. Their data gives details of transactions, including the trading capacity of each participant and the trading direction, which enables them to break down dealers’ trading profits into an execution component and a timing component on a trade-by-trade basis. The execution component of trading profit is the effective spread the dealer charged customers, while the timing component of trading profit is the position revenue dealers earned from price movement. As the futures market is a very liquid market, Manaster and Mann use the one-minute price benchmark and five-minute price benchmark to calculate position revenue.

A few of their findings contradict theoretical predictions. First, they find that when customers trade with market makers, they do not necessarily have executive disadvantage (negative execution in their paper). In fact, they frequently have positive execution. Second, on average, market makers earn positive trading profit; and not only do they enjoy positive execution profit, but they also have positive timing profit. This finding is more pervasive at higher volume quartiles. Third, they find that when market maker’s timing profit is high, customer execution costs are also high. They also find that market makers seem to give up some of their execution advantage in order to make a favorable trade. This finding suggests market makers may act strategically, and this strategic trading behavior is the focus of the research by Neuberger and Hansch (1996).

Neuberger and Hansch (1996) investigate the strategic trading behavior of equity dealers on the London Stock Exchange. They argue that if dealers can learn information from order flow, they may trade strategically in order to make money on their own account whilst not fully reveal the information. They project that dealers can differentiate informed trades and uninformed trades, and if they do act strategically, it should be reflected in the profitability of different types of trade. The informed trades and uninformed trades are defined based on trade size and trade direction relative to dealers’ pre-trade inventory position. So in this paper, the focus is on breaking down trade types and estimating the revenue from different trade types, rather than decomposing the components of revenue itself.

Using one-year detailed transaction data from 1991 to 1992 for 30 liquid stocks, they find that the majority of the market makers actually made trading losses over the year, and that overall, trading revenue margin is zero. They find that revenue from different types of trade is different, that dealers earn less from informed trades than they earn from uninformed trades. However, they find that the higher proportion of uninformed trades a dealer executed, the less a dealers’ overall trading revenue margin was. The finding that dealers who execute more informed trades make significantly more money on these trades than dealers who execute less informed trades, suggests that dealers learn from the informed order flow.

Other researches that examine dealers’ trading behavior from different aspects have made similar findings that dealers may trade strategically but overall make very low profit margins – not significantly different from zero. For example, Hansch et al. (1999) examine the effects of preferencing and internalization of order flows on execution cost and dealers’ profit on the London Stock Exchange. They find that on average, dealers have net trading losses as their spread revenue is exceeded by the position loss. When breaking down the trade into size categories, they find dealers make money on small trades, break even on large trades, but lose money on medium-sized trades. One important aspect that those papers haven’t
investigated is whether a dealer's revenue is also related to his portfolio consideration. Many papers have argued the importance of considering portfolio effect on dealers' trading. In the original inventory model of Ho and Stoll (1983), the inventory position of the dealer is one determinant factor of his pricing rule. Later empirical works, such as that of Naik and Yadav (2003a), particularly emphasize the importance of a dealer's portfolio consideration in his/her trading behavior.

Hansch and Saporta (1998) investigate the trading revenue of UK government bond (gilts) market makers, considering dealers' positions in both the cash market and the derivative market. In this study, they have detailed transaction records of gilts market makers, including their derivative transaction records and actual daily inventory positions. They find that in contrast to equity dealers, gilts dealers earn positive gross trading revenue, although this is not statistically significant. This positive gross trading revenue is not affected whether the dealer's derivative position is considered or not, although they do find there are offsetting effects between a dealer's cash position and his derivative position. Trade types do have effects on dealers' trading revenue. Dealers earn high trade margins in small and large trades, with medium-sized trades offering the lowest margins. After decomposing dealers' revenue into spread revenue and position revenue, they find that, in sharp contrast to other previous findings in the equity market, dealers still earn positive position revenue.

An analysis of dealers' trading revenue has also been conducted in the foreign exchange market. Lyons (1998) examines the trading revenue of one active DM/$ dealer for a week. He finds that this dealer earns significant profit, and besides that, the main profit source is spread revenue, and part of the revenue comes from the dealer's position. Does this imply dealers have information advantage in the foreign exchange market? Ito et al (1998) argue that private information exists in the foreign exchange market, and they define this private information as semi-fundamental private information, which, in contrast to fundamental private information, is unrelated to the payoff of the security but relevant to interim prices. Semi-fundamental private information includes traders' risk aversion, supply and distribution of the risk assets, and any information about trading environments.

At first glance, the trading revenue of dealers varies according to the specific market examined. But it may well support our conjecture that liquidity information itself will bring profit. In the equity market, when fundamental private information plays an important role in driving stock prices, dealers generally make a loss on their position revenue. In markets where fundamental private information plays a minor role, dealers can benefit from liquidity information at their disposal, which may be the reason behind the positive position revenue find in the foreign exchange market (Lyons, 1998) and the government bond market (Hansch and Saporta, 1998). In the corporate bond market, where trades have less fundamental private information content than the equity market, but higher information content than the government bond market or foreign exchange market, to what extent can dealers benefit from their information advantage? This is a question that has not been well examined.

3. DATA

In this study we use two sources of data. The first data set is the London Stock Exchange TDS transaction data, which gives details of trade information. The second data is Quiscore from Qui Credit Assessment Ltd. This data gives the credit-quality information of UK domestic issuers, which we use to infer the credit quality of the issues.

3.1 The transaction data and the cleaning procedure

The transaction data contains the trade reports of the trade participants. It contains the trade volume, trade price, trade time, the identities of both trading parties and their capacities, and also indicates the trade direction for the reporting party (a buy or sell). The trade price is reported as the clean price, without the coupon accrual that is actually paid by the buyer or discounted by the seller, depending on which coupon payment is entitled to the next coupon payment.

The data is very reliable. However, there are a few problems with the data that need to be sorted out. First, some trade records are contra-transaction records. It indicates that another trade record that has the same trade details contains mistakes. In these cases, we delete the contra-transaction records and the trade records associated with them.

Second, in most trades, both sides of the trading parties reported the transaction details, so we have two records for the trade. But some
transactions are only reported once by one of the trading parties. To find out whether the trading records are the same transaction we need to look at its transaction number. Every day the Exchange assigns a unique transaction number for each trade. So if a trade was reported twice by both trade parties, the two records will bear the same transaction number.

Third, there are shaped trades where a dealer or broker splits a big order into a few smaller trades. When dealers split the trade (i.e. Shape), the transaction can be recorded several times depends on the number of times it is split. For example, dealer A split a £10,000 sell order into two, £3,000 with dealer B and £7,000 with dealer C (dealer A, B, C may execute the trade in the capacity of either principal or agent). In this example, we will have three records of different transaction volume, price and quantity. The reported actual trading time may also differ. It often happens that one party may omit the volume or trading value while reporting the trades, so we have zero volume or zero value trade records. Again, we rely on transaction numbers to match all these records. Sometimes we find that the trading value of the buy side of the shaped trade does not equal the trading value of the sell side of the trade, perhaps as a result of a rounding error, as the differences never exceed 10 pence. In these cases we take the average trading value as the real trading value for this trade.

When dealers trade through inter-dealer brokers, the transaction will be reported four times, since inter-dealer brokers report the transaction as two separate transactions. We take this into consideration when calculate transaction numbers and volume.

Fourth, it appears that some prices are wrongly recorded, as we sometimes find that the prices reported at the time are more than 10 times larger (or smaller) than the trade price immediately before or after it. We apply a filter rule as follows: first, we calculate the par value price for each trade. We index the transaction from 1 to T, and let denote the individual trade price. We calculate the price ratio as \( PR = \frac{P_i}{P_n} \), \( n = 1, \ldots, T \), and \( n \neq i \). We define \( PR \geq 10 \) and \( PR \leq 0.1 \) as the out-of-range price ratio, and the band within the in-range price ratio. For each trade record, if the number of the out-of-range price ratio is bigger than the number of the in-range price ratio, this trade record is excluded from the sample.

As many previous studies (such as Neuberger and Hansch, 1996) have done, we have to ignore the trade gains or losses on the initial inventory due to lack of information on the initial inventory. This could affect the results because a dealer may have long or short initial inventory and then close out during the sample period, while the trading revenue we calculated will be based on the trades executed during the sample period and the end period price. There is no perfect solution to this problem, so when we calculate the trading revenue, we only consider the cases where a dealer has made at least two buy and two sell trades on a security.

3.2 Credit rating
Credit rating on individual fixed income security is rare in the UK during our sample period. Instead, we have to rely on credit risk information on issuers to infer the credit quality of issues. We use Quiscore\(^4\) from Qui Credit Assessment Ltd to identify the credit status of firms. As further information on the bond’s seniority is not available, we assign the same credit score to every security that this firm issues. We acknowledge that this is just a rough proxy for a security’s credit quality.

The Quiscore is a measure of the likelihood of company failure in the 12 months following the date of calculation. It is given as a number in the range 0 to 100. There are five bands of Quiscore:

- **81-100** is the secure band. Companies in this band tend to be large and successful public companies. Failure is very unusual and normally occurs only as a result of exceptional changes within the company or its market.
- **61-80** is the stable band. In this band, company failure is a rare occurrence and will only come about if there are major company or marketplace changes.
- **41-60** is the normal band. This sector contains many companies that do not fail, but some that do.
- **21-40** is the unstable band. In this band, there is a significant risk of company failure: they are on average four times more likely to fail than

\(^4\) The Quiscore is based on statistical analysis of a random selection of companies. To ensure that the model is not distorted, three categories are screened out from the initial selection: major public companies, companies that have sort insignificant amounts of unsecured trade credit and liquidated companies that have a surplus of assets over liabilities.
those in the normal band are.

0-20 is the high-risk band. Companies in this sector are unlikely to be able to continue trading unless significant remedial action is undertaken, there is support from a parent company, or special circumstances apply. But a low score does not mean failure is inevitable. Based on these explanations, we categorize the companies into investment grade and non-investment grade companies. Investment grade companies include band 1 and band 2 companies (Quiscore 61-100), and non-investment grade companies include band 3, band 4, and band 5 companies (Quiscore 0-60). Then we assign the securities with the same credit status as the issuers.

4. METHODOLOGY AND ESTIMATION PROCEDURE

4.1 Bid-ask Spread Estimation

The fixed-income market is an opaque market. Because the regulations which apply to the equity market do not apply to the fixed income market, market makers of fixed income securities are not obliged to display bid-ask quotes in fixed-income securities on SEAQ, so no quotes are available in the market. The bid-ask spread has to be estimated. We estimate the realized bid-ask spread by matching the daily buy-side and sell-side transaction prices of a security. This method is similar to the method used by Chakravarty and Sarkar (1999) and Hong and Warga (2000). These two studies exclude bonds that do not have both bid and ask prices for the same day. As a result, their samples are likely to contain only the most liquid bonds. Such a filtering procedure may not be appropriate if the market is generally at the low end of the liquidity spectrum.

We calculate the bid-ask spread as follows:

\[ Bid_i - Ask_i = \frac{1}{N} \sum_{i=1}^{N} P_i^* - \frac{1}{M} \sum_{i=1}^{M} P_i^* \]

where \( Bid_i - Ask_i \) is the realized bid-ask spread for a given bond on day \( t \), \( P_i^* (P_i^*) \) is the price of transaction \( i \) (occuring at the ask (bid), and \( N(M) \) is the number of ask (bid) transactions for a particular bond on day \( t \). If the bid (or ask) transaction price is not available on a particular day, we use the bid (or ask) transaction price of the previous day. If both bid and ask transaction prices are not available, no bid-ask spread is calculated for that day.

Because the bid and ask transactions may not happen on the same day and they may not come from the same dealer consistently, there are occasions where the bid-ask spread is negative. We apply a filter rule to filter those transactions that make the bid-ask spread negative.

4.2 The credit-risk component and liquidity-risk component of price premium

Bond’s credit risk and liquidity risk directly affect its bid-ask spread and therefore dealer’s trading revenue. Before we begin to analyse trading revenue, we first need to quantify the credit risk and liquidity risk. Without credit risk and liquidity risk, the price of a fixed-income security should be determined by its cash flow schedule and the prevailing interest rate. If we define the hypothetical price as the price determined by a security’s cash flow schedule and current interest rate, then any price premium between a risky bond and its hypothetical price should be explained by its credit risk and liquidity risk. We can then decompose the price premium into a credit risk component and liquidity risk component.

This estimation is done in the following steps:

Firstly, the daily price of the hypothetical risk-free bond is constructed using Bank of England spot rates.

The Bank of England provides daily spot rates with a maturity range from six months to 22.5 years. For bonds having maturities longer than 22.5 years, there are two choices for a long-term spot rate: the first is to assume a flat spot rate after 22 years, and second, to use the war loan stock yield to proxy the rate. We choose the second one, as the war loan stock yield is the only indicator investors can have as the long-term interest rate at that point of time, although it is not much different from the 22.5 year spot rate.

For each security, the daily hypothetical prices are calculated as dirty prices, minus the coupon accruals. For each bond at day \( t \), we calculate the hypothetical dirty price as follows:

\[ p_i^t = \frac{c}{2} \left( \frac{\sum_{i=1}^{7} \frac{1}{(1 + 0.01* sp_t)^y} }{6 + 0.01* sp_t} \right)^{100} \]

where:
i: bond i.
t: current trading date.
c: annual coupon rate.
f: the period of compounding.
the interpolated spot rate at the payment date

\[ sp_2 = s_{t-1} + \frac{(s_t - s_{t-1}) \cdot (NP_{t+1} - ND_t)}{365/2} \]

where \( s_t \) is the half-year spot rate known at trading date \( t \), \( NP_{t+1} \) is the next payment date, and \( ND_t \) is the next half-year date to day \( t \).

Where \( y_t \) is the Bank of England spot rate at day \( t \), and \( c \) is the semi-annual coupon payment, and \( N \) is the total number of semi-annual cash flows.

Then the hypothetical clean price is calculated as the dirty price, minus coupon accrual. The coupon accrual is calculated as \( c \cdot \text{day}/180 \), where \( c \) is the half-yearly coupon payment, and \( \text{day} \) is the number of days between the last coupon payment date and the transaction time \( t \).

The price premium is estimated by taking the difference between the hypothetical price and the actual transaction prices on the day when there are trades. If the actual transaction price is a principal bid price, the price premium is calculated as bid price+spread/2-hypothetical price; if the actual transaction price is a principal ask price, the price premium is calculated as the ask price-spread/2-hypothetical price.

Secondly, we estimate the liquidity proxies of each security.

Liquidity can be measured in different dimensions. In this paper we consider the following liquidity proxies:

A. The price impact measure. The lower the market liquidity, the higher the price impact of a certain sized trade. For a thinly traded market, this measure may be a better liquidity proxy than the estimated bid-ask spread, which may contain noise introduced by the estimation procedure.

We estimate the price impact measure using the following regression:

\[ r_{i,d} - r_{j,d} = \alpha + \beta v_{i,d} + \epsilon \quad (3) \]

where:
- \( r_{i,d} \): the return of bond \( i \) on day \( d \).
- \( v_{i,d} \): the pound sterling volume for bond \( i \) on day \( d \).

The estimated \( \beta \) is our measurement for price impact. Bond returns in a given day are defined as the difference between the bond price on transaction day \( t-1 \) and transaction day \( t \), plus coupon accrual divided by the bond price on transaction day \( t-1 \), where the bond price is the mid price (bid price+spread/2 or ask price-spread/2). If there are more than one bid or ask trades in a day, we take the average trade volume and volume-weighted average price. The formula for bond return is as follows:

\[ r_{i,d} = \frac{P_t - (P_{t-1} + c \cdot \text{day} / 180)}{P_{t-1}} \quad (4) \]

where \( P_t \) is the mid-price of day adjusted for coupon accruals. \( \text{day} \) is the number of days between the last coupon payment day to the transaction day \( t \). \( c \) is the half-yearly coupon payment of this bond.

When liquidity is low, price impact is large per unit of volume. So the price impact measure should be negatively related to liquidity status.

B. Turnover, which is the total pound value of transactions during the sample period, is presented in million pounds. The higher the turnover, the higher the market liquidity.

C. Number of trading days, which is the total number of days when a security has been traded. This is an indicator of trading frequency. It is positively related to liquidity.

D. Number of market makers, which is the total number of dealers who have traded the security as principal. A security should be more liquid if it has a lot of dealers making market on it.

Finally, we assume that credit risk and liquidity status stay the same over three months, and, using the Quiscore as security’s credit risk proxy, we decompose the price premium into liquidity risk component and credit risk component using the following regression:

\[ \text{Premium}_{i} = \alpha \cdot \text{Credit}_{i} + \beta \cdot \text{Liq}_{i} + \epsilon \quad (5) \]

Where \( \text{Premium}_{i} \) is the average daily price premium for bond \( i \). \( \text{Credit}_{i} \) is the Quiscore for bond \( i \) and
is the following liquidity measure for bond \( i \). The price impact measure, total turnover, and total number of dealers. All explanation variables have been standardized. We assume that cross-sectional bond risk premium is linear to credit risk and liquidity risk, and the components of this premium are constant all through the three-month sample period. We use the White’s method to correct for heteroscedasticity.

4.3 The interest rate risk estimation

The interest rate exposure is measured by the duration. The most widely used duration measure is the modified Macaulay duration (henceforth, simply referred to as duration). The duration \( D \) at time \( t \) of bond \( i \) maturity at time \( T \) is calculated as follows:

\[
D_{i,t} = \frac{1}{P_{i,t}} \sum_{s=1}^{s_{i,t}} \frac{sC_{i,s,t}}{(1+y_{i,s,t})^s}
\]

(6)

Where \( P_{i,t} \) is the market price of bond \( i \) at time \( t \); \( C_{i,s,t} \) is the coupon received from bond \( i \), \( s \) periods after time \( t \); and \( y_{i,s,t} \) is the yield to maturity on bond \( i \) at time \( t \).

A dealer’s portfolio duration \( S \) is defined as follows:

\[
S_{k,i} = \frac{N_{i}V_{i,k}^{*}D_{i,k}}{100}
\]

(7)

where \( V_{i,k} \) is the pound sterling value of the position (duly signed) of dealer \( k \) in bond \( i \) at the end of day \( t \), and \( D_{i,k} \) is the modified duration of bond \( i \) as defined in the equation above.

There are some practical issues to consider in estimating the duration. First we only have clean price for the transaction. Based on market practice, the duration is calculated using dirty price, that is, the clean price plus the coupon accruals.

\[
p'_{\text{dirty}} = p'_{\text{clean}} + c + \text{day}/180
\]

(8)

where \( c \) is the half-yearly coupon payment, and \( \text{day} \) is the number of days between the last coupon payment date and the transaction time \( t \).

Second, bonds are traded daily, and it is possible that the next cash flow is not exactly six months later. So the duration calculation has to be revised to include the fraction period discount (See Tuckman (2002) for examples of bad days). The modified duration is therefore calculated as follows:

\[
D_{i,k}^{\text{M}} = \frac{1}{P_{i,k}} \left[ \sum_{n=0}^{N_{i}+\tau} \frac{c}{(1+y_{i,n/2})^{n+\tau}} - \frac{100}{2} \left( \frac{N_{i}+\tau}{(1+y_{i,n/2})^{N_{i}+\tau}} \right) \right]
\]

(9)

Where

\( N \): the number of semiannual coupon payments.
\( c \): the semiannual coupon payment.
\( \tau \): the fraction of semiannual coupon that is unpaid.
\( y_{i,n/2} \): the yield to maturity of bond \( i \) at time \( t \), calculated using dirty price.
\( p'_{\text{dirty}} \): the dirty price calculated as the clean price plus the coupon accruals.

4.4 The trading revenue estimation

In this study we estimate dealers’ total trading revenue for the period August 1, 1994 through October 30, 1994. An accurate estimation of trading revenue requires the knowledge of the dealers’ initial inventory position. Due to a lack of this critical information, we assign all the dealers zero initial inventories as previous studies do. Therefore, we only look at the revenue that dealers generated over this specified period. In line with all the previous studies, we also ignore the dealers’ commission\(^6\).

Dealers’ trading revenue contains spread charges for executing trades, and profit from inventory through price movements. Fixed-income security also pays coupons that shall be included in trading revenue.

We follow the same procedure and notation of calculation trading revenue as Hansch and Saporta (1998). The notions are explained as follows: \( J \) denotes the total number of dealers in the market, and letter \( j \) indicates the individual dealer.
dealer. K denotes the overall security sample in the market, and k indicates the individual security. Transactions are indexed by t, and T denotes the end transaction. D denotes the last day in the sample period. P denotes the prices, and VWAP is the value-weighted average price. Q denotes the signed quantity of transactions; for fixed income securities, it is the nominal value. If it is a dealer buy (customer sell), Q<0, and if it is a dealer sell (customer buy), Q>0. C denotes coupon payment, with the daily coupon rate denoted by c. Dealer’s inventory is denoted by the letter I.

The accrued interest is the amount of interest that would be paid if the interest were paid each day. We calculate the coupon payments on the dealer’s end-of-day inventory on a daily basis. The total coupon a dealer j receives is

$$C_j = \sum_{k=1}^{K} \sum_{t=0}^{D} q_{i,j,k} I_{j,i}$$

The revenue measure includes three components, i.e. the spread revenue, the position revenue from end-of-period inventory, and the accrued interest earned during the trading period. We define dealer j’s total revenue as follows:

$$TR_j = \sum_{k=1}^{K} \left( \sum_{t=0}^{D} Q_{i,k} P_{i,k} + VWAP_{i,k} \sum_{j=1}^{J} Q_{j,k} \right) + \sum_{j=1}^{J} \sum_{i=1}^{I} \left( p_{j,i} - d_{j,i} \right)$$

The first term shows the revenue generated from trading, and the second term shows the estimated value of accumulated inventory. The third term is the accrued interest during the trading period.

Similarly, we define that for a security, the accumulated trading revenue is as follows:

$$TR_k = \sum_{j=1}^{J} \left( \sum_{i=1}^{I} Q_{i,k} P_{i,k} + VWAP_{i,k} \sum_{j=1}^{J} Q_{j,k} \right) + \sum_{j=1}^{J} \sum_{i=1}^{I} \left( p_{j,i} - d_{j,i} \right)$$

In this measure, the revenue from trades between dealers will be cancelled, so it shows the dealers’ gain as a whole against the customers in security k.

5. EMPIRICAL RESULTS
5.1 Descriptive statistics
In this study we analyze the trading revenue of fixed-income dealers on the London Stock Exchange over the period August 1994 to October 1994.

Table 1 gives the descriptive statistics for the transaction data. Fixed-income securities with similar characteristics are high substitutes. As we discussed previously, trading revenue may reflect this pattern. We group bonds into different categories based on their credit-risk status and term to maturity. Based on the credit status of issuers, we group securities into investment grade bonds, non-investment grade bonds according to their Quiscore bands, and bonds whose credit status we do not know. Only UK domestic firms have Quiscores, so our investment and non-investment bonds are limited to domestic bonds. Other bonds with unknown credit status include domestic bonds, foreign bonds and some Eurobonds.

For each category of bonds, we further stratify them into: Shorts (less than seven years to maturity), Mediums (between seven and 15 years to maturity), Longs (more than 15 years to maturity), and Undated (including irredeemable bonds and preference shares).

Pane A reports the overall market activities of security trading. We have 1,452 fixed-income securities traded in the market over the sample period. Of all the securities, 352 are investment grade bonds, 148 are non-investment bonds, and 952 are securities with unknown credit grades. Over the sample period, the total market turnover is £5.45 billion. Transactions on investment grade and non-investment grade securities count for 26.23% of total market turnover. Trading in investment grade bonds is concentrated in Longs (68.38% of turnover), and trading in non-investment grade bonds is concentrated in Mediums (44.31% of turnover). Across the time to maturity span, trading is heavier in the long end than the short end: total turnover in Shorts is £0.84bn (15.46%), turnover in Mediums is £1.21bn (22.19%), in longs it is £1.5bn (27.41%), and in Undated it is £1.91bn (34.94%).

Trading activities are different across security categories. In investment-grade bonds, short-term bonds were traded the most actively, while in non-investment grade bonds, undated bonds are traded most actively. The undated bonds also receive most trades in bonds with unknown grade.

Over this period, 91 dealers make markets (traded as principals) on 1,452 securities. Although we can only identify the credit status for 34.95% of total securities, we find that most market-makers have made markets on them, especially on the investment grade bonds. Undated securities
receive more market making than any other fixed-term security.

Over our sample period, the average trade size in the market was £0.17m nominal. Mean trade size generally exceed the median, suggesting a strong left skewness of the size distribution. The different concentration of trading activity and turnover implies that trade size varies across bond categories. Short investment-grade bonds are traded very actively, but the mean trade size is small (£16,170), and the mean far exceed the median (only £1,150), indicating that most trades in this sector are retail trades. This pattern can be found in both medium and undated investment-grade bonds, except that the long investment-grade bonds record an average trade size of up to £0.6m, with £0.1m being the median trade size. This suggests that institutional trades are concentrated in long bonds in the investment grade. For non-investment-grade bonds, the average size of trades is generally higher, but the median trade size never exceeds £50,000. For unknown grade bonds, long bonds record the biggest trade size (roughly £0.9m), which is more than five times the market’s mean trade size. The median trade size (£0.3m) is almost 30 times the overall market median (£13,650). The largest trade is as high as £101m!

Panel B reports the dealers’ trading activities according to transaction category. Not surprisingly, most trades happen between dealers and institutions (including brokered trade and direct trading between principals and customers). This type of transaction accounts for 90% (28,640) of the total number of transactions. Direct and brokered inter-dealer trades are few in this period, perhaps reflecting the illiquidity of the market and/or the reluctance of risk-sharing among dealers. Seven percent (2,338) of trades are executed by agency cross, in which the public’s orders are matched exactly. Total turnover between principal and institutional trade accounted for 87% of total turnover. The average trade size is £0.165m, and most of are wholesale trades. Brokered and direct inter-dealer trades, although accounting for only 6.7% of total turnover, has the largest trade size of £0.8 and £0.28m, respectively. Agency crossed trades account for 6.6% of total turnover, but the trade sizes are the smallest. Most agency crossed trades are retail-sized trades.

The distribution of the number of trades and trading size is stable across different bond categories.

5.2 The credit spread and liquidity spread
5.2.1 The price premium
For each security whose credit status we know, we estimate the price premium between the actual transaction price and the hypothetical price. We only consider bonds that have been traded at least for three days, have at least three principal bid trades, and three principal ask trades, where the trades did not take place simultaneously. We further exclude a few securities where the descriptions are not complete. Finally we have only 101 securities.

Table 2 summarizes the price premium. We have 66 investment-grade bonds, with a total turnover of £6.11 million. The average price premium is 10.86 pence. Because they are investment-grade bonds, some of them have very good credit quality. The minimal price premium is only 0.01 pence, but the maximal price premium is 51.88 pence. We also have 35 non-investment grade bonds with a total turnover of £3.43 million pounds. The average price premium is 15.26 pence, with a minimal price premium of 1.26 pence and a maximal price premium of 83.26 pence. On average, the price premium is higher for non-investment grade bonds than the investment-grade bonds.

5.2.2 The components of price premium
The price premium between the transaction price and the hypothetical price has two main components: the credit-risk premium and the liquidity-risk premium. In this section we deconstruct the two components.

Table 3 shows the results for the deconstruction. We expect the price premium to be negatively related to the credit quality and the liquidity level. The Quiscore is consistently negatively related to the price premium, indicating that credit risk is negatively related to price premium. The price impact measure is positively related to the price premium, which is consistent with the expectation that low liquidity status increases the price premium. This relation is confirmed by using the turnover and number of trading days as the liquidity proxy, that we find a negative relation between these two proxies and the price premium. It does not change the result to regress

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7 Hansch and Saporta (1998) estimate that the average trade size in the gilts market is roughly £2.9m nominal and the maximum trade size is £645m nominal, over the period October 10, 1995 to May 31, 1996.

8 Some securities have zero maturity dates and zero coupon rates.
the premium on all the explanation variables. However, we do not find a statistically significant relationship from these regressions.

5.3 Bid-ask spread and its determinants

Table 4 summarizes the results of estimated bid-ask spread. Panel A presents the results of securities included in price premium estimation only. Panel B presents the results of all spread estimation samples. Securities included in Panel A are traded more frequently than securities included in panel B, but the results are similar. The average bid-ask spread is around 100 basis points. This estimation is greater than estimations in the Gilt market where most gilts have bid-ask spread less than 50 basis points (Hansch and Saporta, 1998). We find that investment-grade securities have a slightly higher bid-ask spread than the non-investment grade securities. This may be caused by the slightly higher average trading volume in non-investment grade securities.

Bid-ask spread can be affected by many factors. The inventory theory suggests that dealers can set the bid-ask spread to offset inventory risk. So the risks of the security will affect the bid-ask spread. For corporate bonds, the usually considered risks are credit risk and interest-rate risk. However, as a proxy for liquidity, bid-ask spread is also affected by other liquidity measures that reflect different aspects of liquidity. To see the determinants of the bid-ask spread, we estimate the following two regressions:

\[ y_{ba}^{(1)} = \alpha + \beta_D D_j + \beta_{Quiscore} Quiscore_j + \epsilon_j \] (13)

\[ y_{ba}^{(2)} = \alpha + \beta_D D_j + \beta_{Quiscore} Quiscore_j + \beta_L L_j + \epsilon_j \] (14)

where \( y_{ba} \) is the bid-ask spread of bond \( j \), \( D \) the duration for bond \( j \), Quiscore is the Quiscore that represents the credit risk for bond \( j \), and \( \alpha \) is the corresponding coefficient of Quiscore from equation (1). \( L \) is the liquidity measure for bond \( j \). We use the following liquidity measurements: price impact, turnover, and the number of trading days. The liquidity measures are timed by the absolute value of the corresponding coefficient \( \beta \) obtained from equation (1). All the measures are standardized except for the price impact measure. To correct for heteroscedasticity, we use White’s correction for the standard error of estimators.

The first regression tells us how bid-ask spread is affected by the risks related to future cash flow; the second regression tells how liquidity risk adds explanation to the bid-ask spread, and also compares the effects of different liquidity proxies.

Table 5 summarizes the regression results.

The bid-ask spread should increase with the risk of a security. Without the liquidity risk proxies, the bid-ask spread is positively related to interest risk but negatively related to the credit risk (the higher the Quiscore, the better the credit quality of a security). The results are not statistically significant. They show that there should be other factors that affect the bid-ask spread.

After adding the liquidity proxy, we find that when using turnover as the liquidity proxy, it significantly explains the bid-ask spread. At the same time the interest rate risk is also a significant factor of the bid-ask spread. Although the price impact measure and trading days have the expected relation with the bid-ask spread, they do not have a significant relation with the bid-ask spread. Credit risk seems to play a minor role in bid-ask spread determination. This may be because the sample securities have such high credit quality that the credit risk is not prominent.

When using the duration, Quiscore and all the liquidity proxies as the explanation variables, we find that turnover still has the most significant effect on the bid-ask spread.

Overall, our results may suggest that interest rate risk and liquidity risk play an important role in determining the bid-ask spread of the fixed income securities. Credit risk may be a factor that is less important than liquidity risk, which is best proxied by the turnover of a security.

5.4 Trading revenue

5.4.1 Summary of dealers’ trading revenue on individual securities

Table 6 gives the summary of trading revenue margins for the whole market-making industry and for different security categories. Securities are grouped by their credit status and time to maturity (TTM).

We consider all securities that have been traded by dealers as principals, and consider only the transactions that are principal trading. This restricted sample contains 574 securities, which account for 40% of securities traded in the market but account for 63.76% of total market turnover over the sample period. We identify 152 investment-grade bonds that account for 22.4% of total sample turnover, 76 non-investment grade bonds that account for 13.6% of total sample
turnover, and the remaining 346 bonds with unknown credit status that account for 64% of total sample turnover. Sixty one out of 91 dealers made market on these securities. So this sample is well representative of dealers’ market-making behavior.

Trading revenue varies from a loss of £1.13 million in short bonds with unknown credit status to a gain of £1.36 million in the investment-grade long bonds. The market-making industry as a whole earns positive trading revenue of £1.05 million over the three-month sample period.

For the whole industry, market making appears profitable. The overall revenue margin is 3.02 basis points. Dealers make profits on investment-grade bonds, but in general lose on non-investment grade bonds. We do not find that time to maturity has any significant effect on trading revenue.

We also identify the percentage of losers in security categories. It shows that for each security category, the percentage of losers seldom exceeds 50%.

5.4.2. Rank correlation between trading revenue and order flow on individual security
The above results show that revenue margins are different across dealers and securities, and turnover may be an important factor that determines a dealer’s revenue.

As an initial test, we perform a rank correlation test on a dealer’s trading revenue and his trading volume. The hypothesis is that dealers who observe more order flow or trades gain information from these order flows, which they can use to generate profit.

We did two sets of rank correlation tests. The first test is the rank correlation between the dealer’s total trading revenue and his turnover on a security. The second test is between a dealer’s trading revenue margin and his turnover margin on a security. The turnover margin is measured by the proportion of the dealer’s turnover on the security’s total turnover executed by all principals.

Table 7 summarizes the results. We arrange the securities by the number of the dealers who act as principals to control for the competition on the security. Whatever the level of competition, we expect to see that the dealers with higher turnover gain more. R1 is the correlation coefficient between each dealer’s ranked revenue and ranked turnover on a security, and t1 is the corresponding t statistics. R2 is the correlation coefficient between each dealer’s ranked revenue margin and ranked turnover margin on a security, and t2 is the corresponding t statistics.

We define a security with or less than three market makers as a security with less competition, and securities with more than three market makers as a security with higher competition. There are 430 securities that have less than three dealers making markets, and 144 securities each have more than three market makers. Except for the R2 for the highly competitive securities, all the correlation coefficients are significantly positive. This shows that trading revenue does increase with dealers’ turnover. When we look at the correlation between a dealer’s revenue margin and his turnover margin, it still gives the same positive relationship. It shows that the dealer’s revenue does increase with his competitive advantage on order flow, perhaps in a nonlinear way\(^9\). Taking the sample as a whole, both correlation coefficients are significantly positive.

The finding shows that generally, the more turnover the dealer has, the higher revenue and revenue margin he will get. But it’s also interesting to notice that this rule does not apply to every dealer. We will address the issue of heterogeneity of dealers in a later section.

5.5 Decomposition of trading revenue
Trading revenue has two components, the spread component and the position component. According to microstructure theories, dealers may earn positive spread revenue, but will make negative position revenue. However, if a dealer has an information advantage that is significant enough for him to make money, he may be able to earn positive position revenue.

5.5.1 The components of trading revenue margin
Table 8 summarizes the components of trading revenue based on security credit status and time to maturity. We decompose a dealer’s trading revenue into spread revenue and position revenue. The position revenue margin of dealer \(j\) on security \(i\) is calculated as the difference between

\(^9\) We have performed the test using a finer definition of competition to stratify bond category. The correlation coefficients are always positive, but not always significant across categories. The results may be affected by our sample size. But it also shows that when the competition is strong, the relation between revenue and order flow advantage is more apparent. This is especially the case for a few securities where there are more than 10 market makers. The R1 are all significantly positive and exceed 0.5.
the dealer’s revenue margin (based on his own turnover on this security) and the security’s bid-ask spread.

We restrict the sample to securities where dealers make positive revenue. We have 300 securities with 47 dealers making markets in these securities. The bid-ask spreads of these securities are generally large, which on average exceed 100 basis points. Although dealers make positive revenue on these securities, it mostly comes from the bid-ask spread revenue. Based on the security’s time to maturity, we find that dealers only make positive position revenues on securities at the long end, but make losses on securities at the short end. Overall, dealers make an average position loss of 11.25 basis points.

The results show that, in general, the market-making industry of the fixed income market has a tight profit margin. This result is consistent with the theory predictions that dealers set the bid-ask spread to compensate for the possible loss to the informed traders.

5.5.2. The determinants of position revenue
Position revenue reflects a dealer’s ability to profit using his information. The above section shows that dealers make position revenue on some securities but lose on others. It is interesting to explore the issue a bit further to understand the possible determinants of position revenue. Especially, we examine how interest-rate risk, credit risk, and liquidity risk affect position revenue. We estimate the following regression:

\[ \text{Pos}_{i,j} = \beta_1 D_i + \beta_2 \text{Credit}_i + \beta_3 \text{Tov}_{i,j} + \beta_4 \text{Bas}_i + e_{i,j} \]  

Where \( \text{Pos}_{i,j} \) is the position revenue margin for dealer \( j \) on security \( i \); \( D_i \) is the duration of security \( i \); \( \text{Credit}_i \) is the credit proxy of security \( i \); \( \text{Tov}_{i,j} \) is the turnover margin of dealer \( j \) on security \( i \). We use it as the liquidity proxy based on the analysis in previous sections; and \( \text{Bas}_i \) is the average bid-ask spread on security \( i \). We use the White’s correction to adjust for heteroscedasticity.

Table 9 summarizes the results. Not surprisingly, the bid-ask spread has the most significant negative relation to position revenue. As expected, liquidity does contribute to position revenue. Position revenue increases with the dealer’s turnover margin and decreases with the bid-ask spread. Credit risk and interest risk of the security have a positive relation with the dealer’s position revenue margin. However, with the exception that the bid-ask spread has a significant effect on position revenue; none of the other factors significantly affect position revenue statistically.

5.6 The heterogeneity of dealers
Until now we have treated all the dealers as a group. In fact, dealers are different in their dealing capacity and so may have different levels of order flow advantage. This is especially true in a dealership market, where normally a few dealers do the majority of trades on a security. Those dealers observe more order flows and have contact with more customers, so they may obtain better liquidity information than other minor dealers in this security.

We examine the heterogeneity of dealers by comparing the trading revenue margins of the top dealers and the non-top dealers. Top dealer is defined as the dealer who has the highest principal trade turnover on a security, and non-top dealers are the other dealers who trade on this security.

We then estimate the following regression:

\[ \text{Mar}_{i,j} = \alpha + \beta D + \sum_{n=0}^{2} \gamma_n \text{C}_n + e \]  

Where \( \text{Mar}_{i,j} \) is the revenue margin for dealer \( j \) on security \( i \), and the revenue margin is defined as the dealer’s trading revenue on a security divided by the total turnover of a security in the sample period. \( D \) is a dummy variable which takes the value 1 when the dealer is a top dealer and zero otherwise. \( \text{C}_n \) is a credit status dummy for the security. When \( n=0 \), \( \text{C}_0=0 \) and no other \( \text{C} \) exist in the equation so there is no credit status dummy exist in the equation. The security sample has three credit statuses: investment grade, non-investment grade and no credit information. When \( n=1,2 \), \( \text{C}_n \) is a dummy variable which takes the value 1 when the security is an investment grade and non-investment grade security, respectively.

We restrict the sample to the securities that have bid-ask spread estimation, and also have at least two principal dealers. We are left with 110 securities. But over 47 dealers make markets on these securities, so it should to a good extent reflect dealers’ trading results. Table 10 presents the results for the above regression. The first regression does not include the credit status dummy where the second regression includes two
credit status dummies. $\beta$, the coefficient of top dealer dummy represents the difference between the top dealer and the non-top dealer in terms of the relationship with the revenue margin. We find that whether to take into consideration the credit status of security or not, $\beta$ is significantly positive. It suggests that the top dealers in general earns significantly large revenue margin.

To make a direct comparison between dealers and show the economic significance of the results, we present the average figures of the revenue margin in Table 11. It is clear that top dealers earn much higher revenue than the non-top dealers. Top dealers earn positive revenue in every bond category, while non-top dealers make losses on non-investment grade bonds. Overall, the top dealers make an average revenue margin of 33.79 basis points, and non-top dealers only make revenue margin of 1.65 basis points. In sum, the results show that dealers are heterogeneous, and order flow information advantage does make a difference in profit earning.

6. CONCLUSION

In this paper, we examine whether liquidity information advantage leads to profit by examining the trading revenue of dealers in London’s fixed income market during the period August 1994 to October 1994. In such a market, with opaque transaction information and a little private fundamental information, dealers have more information advantage on market liquidity than public investors. Does this non-fundamental information transfer into profit? We examine whether market making in this market is profitable and whether dealers with a higher level of liquidity information outperform dealers with a lower level of liquidity information.

First, we estimate the transaction costs of corporate bonds. Using different liquidity proxies, we find that liquidity proxies do affect our bid-ask spread measure, as expected.

Second, we estimate dealers’ total trading revenue. The whole market-making industry makes positive total revenue, but a negative revenue margin. It shows there is heterogeneity in individual dealers’ profit-making ability. Our rank correlation test shows that, after controlling for competitions on a security, dealers’ revenue and turnover are significantly positively correlated. So, in general, dealers who observe more order flow make more gain. Our regression result for determinants of trading revenue also shows that trading revenue is positively related to a dealer’s turnover and the liquidity status of the security.

Third, we deconstruct the trading revenue into spread revenue and position revenue. In general, dealers do not make position profit. The result is consistent with theory prediction, that the dealer charges the bid-ask spread to balance his loss to the informed trader. However, we still find position revenue is positively correlated with the dealer’s turnover compared to other dealers. This finding suggests dealers may be different in profit-earning, based on the level of liquidity information they have.

Finally we examine how dealers with different levels of liquidity information differ from each other in profit-earning. After separating dealers into a top-dealer group and a non-top dealer group, we find that, on average, top dealers earn much higher revenue margins than the non-top dealers. This result lends further support to the hypothesis that dealers who observe more liquidity (proxied by order flow) earn significantly more than the others.

To sum up, in this paper we anatomiize dealers’ revenue in the fixed-income market. We find evidence consistent with theory predictions that trading revenue for the market-making industry as a whole is not significantly different from zero. However, we also find evidence that dealers’ liquidity information advantage positively contributes to trading revenue, and the relation may be non-linear. Furthermore, our findings support that since dealers are heterogeneous on liquidity information, dealers with a higher level of liquid information can earn a higher profit than other dealers. Thus, liquidity information is valuable.
Table 1 Descriptive Statistics

This table summarizes the market activities of London fixed income market over the period of August 1994 to October 1994. Panel A gives the summary statistics of the total trade activity, and Panel B summarizes the market activities based on transaction types. # Trade is the number of trade. # Security is the number of securities. # Market maker is the number of dealers.

<table>
<thead>
<tr>
<th>Panel A</th>
<th>Investment grade</th>
<th>Non-investment grade</th>
<th>Unknown grade</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short</td>
<td>Medium</td>
<td>Long</td>
<td>Undated</td>
</tr>
<tr>
<td>Turnover($m)</td>
<td>42.59</td>
<td>130.21</td>
<td>600.64</td>
<td>104.95</td>
</tr>
<tr>
<td># Trade</td>
<td>2633</td>
<td>672</td>
<td>936</td>
<td>2391</td>
</tr>
<tr>
<td># Security</td>
<td>71</td>
<td>49</td>
<td>76</td>
<td>156</td>
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<tr>
<td># Market maker</td>
<td>22</td>
<td>21</td>
<td>21</td>
<td>27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel A</th>
<th>Trade size($1,000)</th>
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</thead>
<tbody>
<tr>
<td>Mean</td>
<td>16.17</td>
</tr>
<tr>
<td>Median</td>
<td>1.15</td>
</tr>
<tr>
<td>Max</td>
<td>2,157.10</td>
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</table>

<table>
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<tr>
<th>Panel B</th>
<th># Trade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Principal-Institution</td>
</tr>
<tr>
<td># Trade</td>
<td>2,554</td>
</tr>
<tr>
<td>Turnover($m)</td>
<td>39.83</td>
</tr>
<tr>
<td>Mean Size($1,000)</td>
<td>39.83</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B</th>
<th>Turnover($m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Principal-Institution</td>
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<td>Mean Size($1,000)</td>
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<table>
<thead>
<tr>
<th>Panel B</th>
<th>Mean Size($1,000)</th>
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<tbody>
<tr>
<td></td>
<td>Principal-Institution</td>
</tr>
<tr>
<td>Mean Size($1,000)</td>
<td>15.59</td>
</tr>
<tr>
<td>Median Size($1,000)</td>
<td>0.00</td>
</tr>
<tr>
<td>Max Size($1,000)</td>
<td>12.20</td>
</tr>
<tr>
<td>Min Size($1,000)</td>
<td>52.96</td>
</tr>
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</table>
Table 2 Summary of Price Premium estimation

This table summarizes the price premium estimation. Price premium is defined as the price difference between a risky security and a theoretic security with same structure but without credit risk or liquidity risk.

#Sec is the number of the risky security included. Turnover is the securities’ total trading value in million pounds. Premium is the average price premium estimated presented in pence. Also presented are the standard deviation, minimal value and maximal value of the price premium.

<table>
<thead>
<tr>
<th>Credit status</th>
<th>#Sec</th>
<th>Turnover (£m)</th>
<th>Premium (pence)</th>
<th>Std</th>
<th>Min (pence)</th>
<th>Max (pence)</th>
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<tbody>
<tr>
<td>Investment grade</td>
<td>66</td>
<td>6.11</td>
<td>10.86</td>
<td>9.27</td>
<td>0.01</td>
<td>51.88</td>
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<tr>
<td>Non-investment grade</td>
<td>35</td>
<td>3.43</td>
<td>15.26</td>
<td>15.44</td>
<td>1.26</td>
<td>83.26</td>
</tr>
</tbody>
</table>

Table 3

This table summarizes the results of this regression:

\[ \text{Premium}_i = \alpha \cdot \text{Credit}_i + \beta \cdot \text{liq}_i + \epsilon \]

Where \( \text{Premium}_i \) is the average daily price premium for bond \( i \). Credit is the Quiscore for bond \( i \) and liq is the liquidity proxy for bond \( i \): the price impact measure PI, total turnover, and total number of trading days. All explanation variables have been standardized. Figures in the brackets are the t values.

<table>
<thead>
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<th>Quiscore</th>
<th>PI</th>
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<th>#day</th>
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<tr>
<td>1</td>
<td>-2.80</td>
<td>1.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.56)</td>
<td>(0.84)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-2.57</td>
<td>-1.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.44)</td>
<td>(-0.66)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-2.60</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.45)</td>
<td>(-0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-2.75</td>
<td>1.12</td>
<td>-1.06</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>(-1.31)</td>
<td>(0.53)</td>
<td>(-0.51)</td>
<td>(0.06)</td>
</tr>
</tbody>
</table>
Table 4 Summary of Bid-ask Spread estimation

This table summarizes the bid-ask spread estimation. #Sec is the number of security included. Turnover is the securities' total trading value in million pounds. Spread is the estimated average bid-ask spread presented in basis points. Also presented are the standard deviation, minimal value and maximal value of the bid-ask spread.

Panel A presents the results of securities included in price premium estimation. Panel B presents the results of all spread estimation sample.

<table>
<thead>
<tr>
<th>Credit status</th>
<th>#Sec</th>
<th>Turnover (£m)</th>
<th>Spread (bp)</th>
<th>Std</th>
<th>Min (bp)</th>
<th>Max (bp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment grade</td>
<td>66</td>
<td>6.11</td>
<td>126.43</td>
<td>79.31</td>
<td>12.50</td>
<td>440.00</td>
</tr>
<tr>
<td>Non-investment grade</td>
<td>35</td>
<td>3.43</td>
<td>100.57</td>
<td>95.26</td>
<td>6.25</td>
<td>483.33</td>
</tr>
<tr>
<td>Panel B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment grade</td>
<td>85</td>
<td>7.17</td>
<td>132.98</td>
<td>92.92</td>
<td>12.50</td>
<td>460.00</td>
</tr>
<tr>
<td>Non-investment grade</td>
<td>46</td>
<td>4.42</td>
<td>94.94</td>
<td>97.93</td>
<td>2.63</td>
<td>483.33</td>
</tr>
<tr>
<td>Other</td>
<td>213</td>
<td>20.13</td>
<td>96.95</td>
<td>86.98</td>
<td>0.75</td>
<td>462.12</td>
</tr>
</tbody>
</table>
This table summarizes the results of bid-ask spread determinants. We estimate regressions that take the following general form:

$$ y_{ba} = \alpha + \beta_1 D_j + \beta_2 (\alpha * \text{Credit}_j) + \beta_3 (\beta * L_j) + \varepsilon_j $$

Where $y_{ba}$ is the bid-ask spread of bond $j$, $C_j$ is the credit risk proxy for bond $j$, $D_j$ the duration for bond $j$, and $L_j$ is the liquidity measurement for bond $j$. We use duration as the interest risk proxy, Quiscore as the credit risk proxy, and the following liquidity measurements: price impact, turnover, and the number of trading days.

<table>
<thead>
<tr>
<th>Duration</th>
<th>Qscore</th>
<th>PI</th>
<th>Turnover</th>
<th>#day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.29</td>
<td></td>
<td></td>
<td>1.96</td>
</tr>
<tr>
<td>2</td>
<td>0.13</td>
<td></td>
<td>-0.24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.30</td>
<td>2.18*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-1.41</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.20</td>
<td></td>
<td></td>
<td>-0.29</td>
</tr>
<tr>
<td></td>
<td>2.01*</td>
<td>1.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-3.61**</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.16</td>
<td></td>
<td></td>
<td>-2.48</td>
</tr>
<tr>
<td></td>
<td>1.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.54</td>
<td></td>
<td></td>
<td>-1.76</td>
</tr>
<tr>
<td>5</td>
<td>0.22</td>
<td></td>
<td>-0.17</td>
<td>-0.28</td>
</tr>
<tr>
<td></td>
<td>1.89</td>
<td></td>
<td>1.32</td>
<td>-0.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.32</td>
<td>-2.69**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.10</td>
</tr>
</tbody>
</table>

Note: * Significant at 5% level
** Significant at 1% level
Table 6 Summary of trading revenue

This table summarizes the aggregated trading revenue of dealers on individual securities. Securities are grouped by their credit status and time to maturity (TTM). Turnover is presented in million pounds. #sec is the number of security. #mm is the number of dealers making market on the group of securities. Revenue is the aggregated trading revenue of dealers in the security group. M is the average revenue margin in basis points. The revenue margin is calculated as the weighted average of dealer’s revenue margin, where the weight is the dealer’s total turnover on a security. The %loser is the percentage number of dealers who make negative revenue on the category.

<table>
<thead>
<tr>
<th>Credit status</th>
<th>TTM</th>
<th>Turnover (£m)</th>
<th># sec</th>
<th>#mm</th>
<th>Revenue (£m)</th>
<th>M(bp)</th>
<th>% loser</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment grade</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td></td>
<td>35.97</td>
<td>31</td>
<td>20</td>
<td>0.06</td>
<td>15.69</td>
<td>0.31</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>112.57</td>
<td>28</td>
<td>20</td>
<td>0.13</td>
<td>11.74</td>
<td>0.46</td>
</tr>
<tr>
<td>Long</td>
<td></td>
<td>552.03</td>
<td>44</td>
<td>19</td>
<td>1.36</td>
<td>24.64</td>
<td>0.50</td>
</tr>
<tr>
<td>Undated</td>
<td></td>
<td>78.64</td>
<td>49</td>
<td>16</td>
<td>-0.47</td>
<td>-59.24</td>
<td>0.43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>779.22</td>
<td>152</td>
<td>34</td>
<td>1.08</td>
<td>13.86</td>
<td>0.44</td>
</tr>
<tr>
<td><strong>Non-investment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td></td>
<td>74.80</td>
<td>21</td>
<td>8</td>
<td>0.06</td>
<td>8.09</td>
<td>0.24</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>238.30</td>
<td>21</td>
<td>17</td>
<td>-0.23</td>
<td>-9.69</td>
<td>0.52</td>
</tr>
<tr>
<td>Long</td>
<td></td>
<td>52.29</td>
<td>10</td>
<td>13</td>
<td>-0.14</td>
<td>-25.94</td>
<td>0.47</td>
</tr>
<tr>
<td>Undated</td>
<td></td>
<td>107.23</td>
<td>24</td>
<td>21</td>
<td>-0.20</td>
<td>-18.91</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>472.62</td>
<td>76</td>
<td>32</td>
<td>0.51</td>
<td>-10.79</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td></td>
<td>482.75</td>
<td>120</td>
<td>33</td>
<td>-1.13</td>
<td>-23.42</td>
<td>0.35</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>688.24</td>
<td>96</td>
<td>38</td>
<td>0.28</td>
<td>4.09</td>
<td>0.41</td>
</tr>
<tr>
<td>Long</td>
<td></td>
<td>785.48</td>
<td>55</td>
<td>20</td>
<td>1.34</td>
<td>16.75</td>
<td>0.41</td>
</tr>
<tr>
<td>Undated</td>
<td></td>
<td>269.27</td>
<td>75</td>
<td>29</td>
<td>-0.01</td>
<td>-0.21</td>
<td>0.36</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>2,225.74</td>
<td>346</td>
<td>56</td>
<td>0.48</td>
<td>2.16</td>
<td>0.39</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>3,477.58</td>
<td>574</td>
<td>61</td>
<td>1.05</td>
<td>3.02</td>
<td>0.39</td>
</tr>
</tbody>
</table>
Table 7

Rank correlation test between dealer’s revenue and turnover

Table 7 summarizes the rank correlation tests between dealer’s revenue and his turnover on individual securities. #dealer is the number of dealer for each security, #sec is the total number of securities in this category. R1 is the correlation coefficient between each dealer’s ranked revenue and ranked turnover on a security, and t1 is the corresponding t statistics. R2 is the correlation coefficient between each dealer’s ranked revenue margin and ranked turnover margin on a security, and t2 is the corresponding t statistics. The turnover margin is calculated as the proportion of dealer’s turnover on the security’s total turnover executed by all principals.

<table>
<thead>
<tr>
<th>#dealer</th>
<th>#sec</th>
<th>R1</th>
<th>t1</th>
<th>R2</th>
<th>t2</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=3</td>
<td>430</td>
<td>0.22</td>
<td>6.33**</td>
<td>0.08</td>
<td>2.34*</td>
</tr>
<tr>
<td>&gt;3</td>
<td>144</td>
<td>0.18</td>
<td>5.39**</td>
<td>0.04</td>
<td>1.18</td>
</tr>
<tr>
<td>Total</td>
<td>574</td>
<td>0.20</td>
<td>8.17**</td>
<td>0.07</td>
<td>2.72**</td>
</tr>
</tbody>
</table>

Note: * significant at 1% level
** Significant at 5% level
Table 8 Decomposition of trading revenue

This table shows the results of trading revenue decomposition based on security credit status and time to maturity. Tover is the total turnover of the securities in million pounds; #sec is the number of the security in the category; #fc is the number of the firms in the category; SP is the average bid-ask spread of the securities and PM is the average position revenue margin of the securities. SP and PM are presented in basis points.

<table>
<thead>
<tr>
<th>Credit Status</th>
<th>TTM</th>
<th>Tover (£m)</th>
<th>#sec</th>
<th>#fc</th>
<th>SP (bp)</th>
<th>PM (bp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td></td>
<td>32.58</td>
<td>16</td>
<td>12</td>
<td>115.32</td>
<td>-51.73</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>97.25</td>
<td>17</td>
<td>15</td>
<td>120.84</td>
<td>-70.81</td>
</tr>
<tr>
<td>Long</td>
<td></td>
<td>492.34</td>
<td>24</td>
<td>14</td>
<td>106.36</td>
<td>52.80</td>
</tr>
<tr>
<td>Undated</td>
<td></td>
<td>76.18</td>
<td>20</td>
<td>12</td>
<td>153.81</td>
<td>-43.49</td>
</tr>
<tr>
<td>Non-investment grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td></td>
<td>59.55</td>
<td>8</td>
<td>7</td>
<td>58.59</td>
<td>-54.67</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>215.95</td>
<td>11</td>
<td>9</td>
<td>81.13</td>
<td>-59.15</td>
</tr>
<tr>
<td>Long</td>
<td></td>
<td>45.42</td>
<td>8</td>
<td>10</td>
<td>73.78</td>
<td>26.60</td>
</tr>
<tr>
<td>Undated</td>
<td></td>
<td>96.16</td>
<td>12</td>
<td>17</td>
<td>141.57</td>
<td>-46.81</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td></td>
<td>307.96</td>
<td>58</td>
<td>23</td>
<td>100.72</td>
<td>-17.23</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>568.44</td>
<td>52</td>
<td>27</td>
<td>106.04</td>
<td>-16.41</td>
</tr>
<tr>
<td>Long</td>
<td></td>
<td>706.70</td>
<td>35</td>
<td>18</td>
<td>88.73</td>
<td>-13.53</td>
</tr>
<tr>
<td>Undated</td>
<td></td>
<td>251.60</td>
<td>39</td>
<td>21</td>
<td>160.39</td>
<td>23.22</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2950.10</td>
<td>300</td>
<td>47</td>
<td>108.67</td>
<td>-11.25</td>
</tr>
</tbody>
</table>
Table 9 Determinants of position revenue

This table summarizes the results for the following regression:

$$Pos_{i,j} = \beta_1 D_i + \beta_2 Credit_i + \beta_3 Tov_{i,j} + \beta_4 Bas_i + \varepsilon_i$$

where $Pos_{i,j}$ is the position revenue margin for dealer $j$ on security $i$; $D_i$ is the duration of security $i$; $Credit_i$ is the credit proxy of security $i$—here we use Quisco as the credit proxy; $Tov_{i,j}$ is the turnover margin of dealer $j$ on security $i$; and $Bas_i$ is the average bid-ask spread of security $i$.

<table>
<thead>
<tr>
<th></th>
<th>Estimation</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>43.49</td>
<td>1.07</td>
</tr>
<tr>
<td>Quisco</td>
<td>10.40</td>
<td>0.43</td>
</tr>
<tr>
<td>Turnover margin</td>
<td>10.94</td>
<td>0.71</td>
</tr>
<tr>
<td>Bid-ask spread</td>
<td>-77.08</td>
<td>-3.00**</td>
</tr>
<tr>
<td>#observation</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

Note: ** significant at 1% level.
Table 10 Comparison of top dealers and non-top dealers

This table summarizes the results for the following regression:

\[ Mar_{i,j} = \alpha + \beta D + \sum_{n=0}^{2} \gamma_n C_n + \epsilon \]

Where \( Mar_{i,j} \) is the revenue margin for dealer \( j \) on security \( i \), and the revenue margin is defined as the dealer’s trading revenue on a security divided by the total turnover of a security in the sample period. \( D \) is a dummy variable which takes the value 1 when the dealer is a top dealer and zero otherwise. \( C_n \) is a credit status dummy for the security. When \( n=0 \), \( C_0 = 0 \) and no other \( C \) exist in the equation so there is no credit status dummy exist in the equation. When \( n=1,2 \), \( C_n \) is a dummy variable which takes the value 1 when the security is an investment grade and non-investment grade security, respectively.

<table>
<thead>
<tr>
<th>( \beta )</th>
<th>( \gamma_1 )</th>
<th>( \gamma_2 )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.07</td>
<td></td>
<td></td>
<td>0.26</td>
</tr>
<tr>
<td>13.80**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55.04</td>
<td>-0.70</td>
<td>-4.98</td>
<td>0.26</td>
</tr>
<tr>
<td>13.78**</td>
<td>-0.19</td>
<td>-0.92</td>
<td></td>
</tr>
</tbody>
</table>

Note: ** significant at 1% level.

Table 11 Revenue margins of top dealers and non-top dealers

This table summarizes top dealer’s revenue margin and non-top dealer’s revenue margin. To make direct comparison between dealers, here the revenue margin is calculated as the dealer’s trading revenue on a security divided by the total turnover a security has in the sample period.

<table>
<thead>
<tr>
<th>Credit status</th>
<th>Dealer</th>
<th>#Sec</th>
<th>#Dealer</th>
<th>Revenue margin (bp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment grade</td>
<td>Top</td>
<td>31</td>
<td>13</td>
<td>36.40</td>
</tr>
<tr>
<td></td>
<td>Non-top</td>
<td>31</td>
<td>29</td>
<td>5.79</td>
</tr>
<tr>
<td></td>
<td>Top</td>
<td>11</td>
<td>7</td>
<td>29.06</td>
</tr>
<tr>
<td></td>
<td>Non-top</td>
<td>11</td>
<td>25</td>
<td>-1.26</td>
</tr>
<tr>
<td>Non-investment grade</td>
<td>Top</td>
<td>69</td>
<td>13</td>
<td>33.56</td>
</tr>
<tr>
<td></td>
<td>Non-top</td>
<td>69</td>
<td>41</td>
<td>0.81</td>
</tr>
<tr>
<td>Others</td>
<td>Top</td>
<td>110</td>
<td>20</td>
<td>33.79</td>
</tr>
<tr>
<td></td>
<td>Non-top</td>
<td>110</td>
<td>47</td>
<td>1.65</td>
</tr>
<tr>
<td>All</td>
<td>Top</td>
<td>110</td>
<td>20</td>
<td>33.79</td>
</tr>
<tr>
<td></td>
<td>Non-top</td>
<td>110</td>
<td>47</td>
<td>1.65</td>
</tr>
</tbody>
</table>
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